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(54) SYSTEM AND METHOD FOR ROTATING A THREE-DIMENSIONAL (3D) OBJECT DURING PRINTING OF THE OBJECT

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B41J 3/407 (2006.01)

(52) **U.S. Cl.**
CPC ***B41J 3/4073*** (2013.01); ***B41J 29/00*** (2013.01)

(58) **Field of Classification Search**
CPC B41J 3/4073; B41J 29/00; B41M 5/035
See application file for complete search history.

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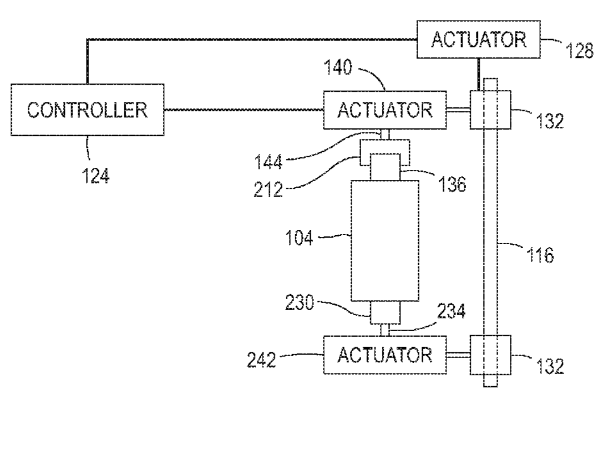
(57) **ABSTRACT**

A direct-to-object printer includes an object rotating subsystem. The object rotating subsystem includes an actuator with an output shaft, a holder mounted to the output shaft, the holder being configured to grip a portion of the object, and a controller operatively connected to the actuator. The controller is configured to operate the actuator to rotate the holder and the object gripped by the holder to enable at least one of the printheads in a printer to print a portion of a circumference of the object that is longer than a width of the at least one printhead.

20 Claims, 5 Drawing Sheets



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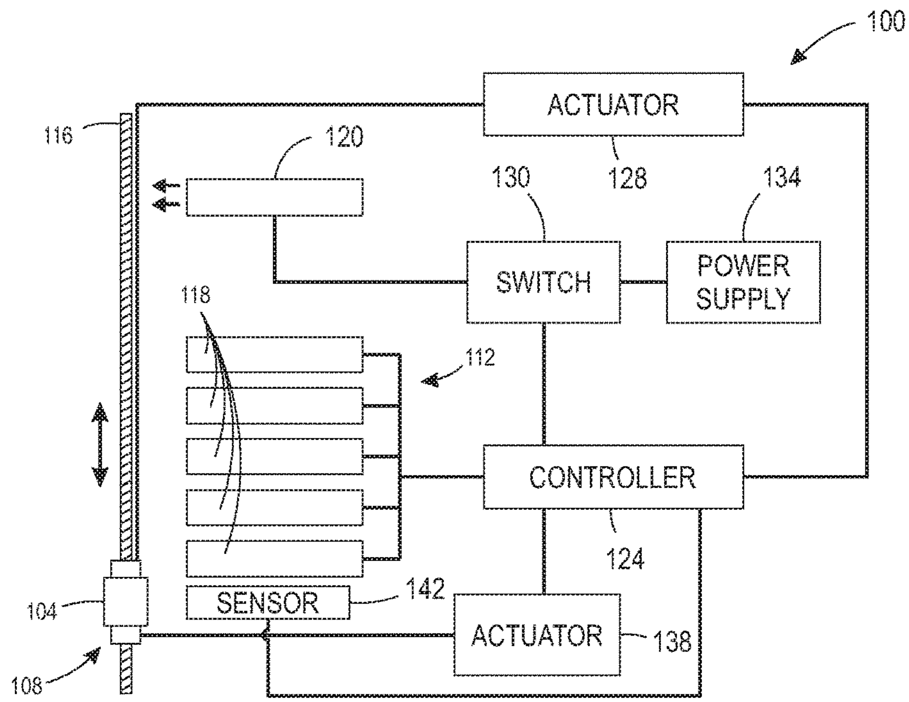
100
ACTUATOR
116
120
128
130
134
SWITCH
POWER SUPPLY
118
112
CONTROLLER
124
SENSOR
142
ACTUATOR
138
104
108

FIG. 1A

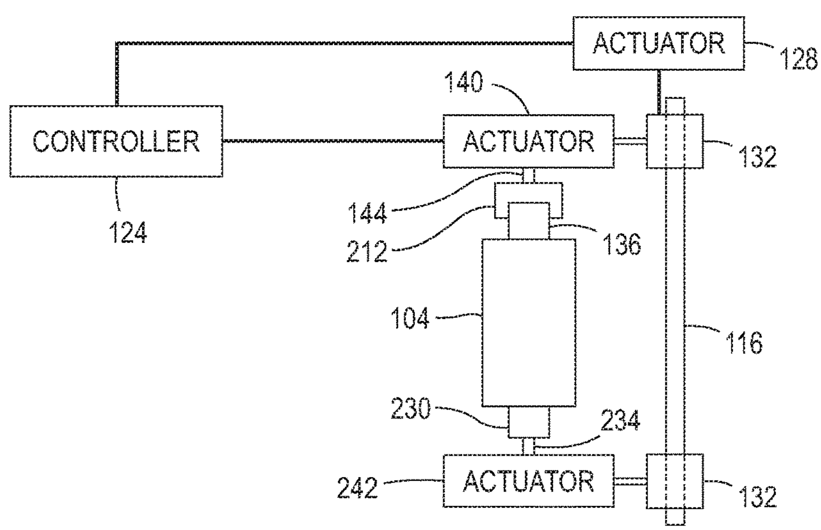
ACTUATOR
128
140
CONTROLLER
ACTUATOR
132
144
212
136
124
104
116
230
234
ACTUATOR
242
132

FIG. 1B

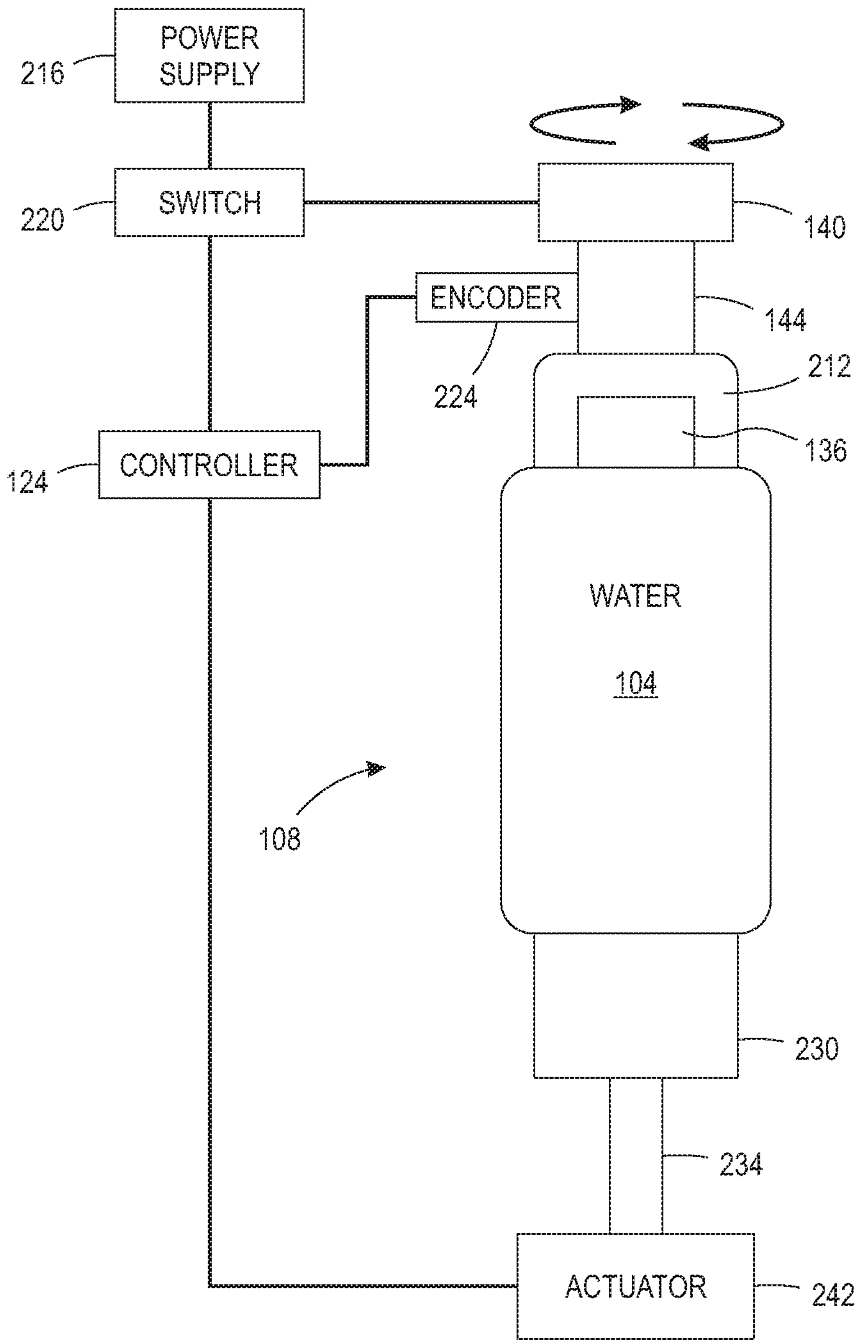
POWER SUPPLY
216
SWITCH
220
140
ENCODER
144
224
212
136
CONTROLLER
124
WATER
104
108
230
234
ACTUATOR
242

FIG. 2

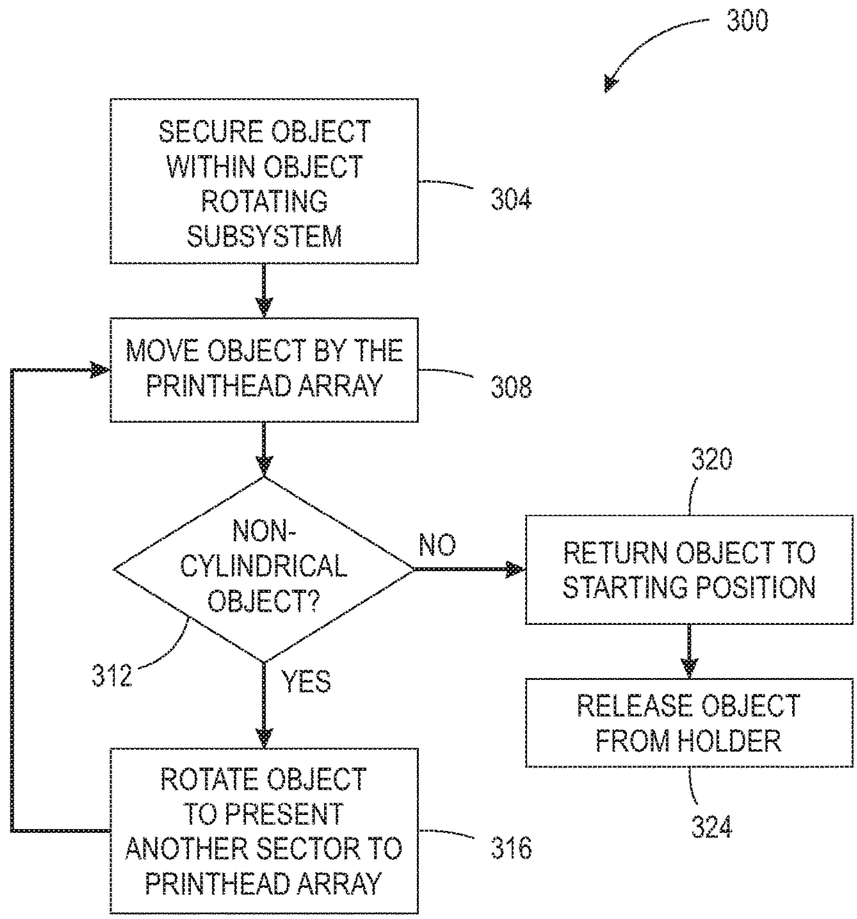
300
SECURE OBJECT WITHIN OBJECT ROTATING SUBSYSTEM
304
MOVE OBJECT BY THE PRINTHEAD ARRAY
308
NON-CYLINDRICAL OBJECT?
312
NO
YES
RETURN OBJECT TO STARTING POSITION
320
RELEASE OBJECT FROM HOLDER
324
ROTATE OBJECT TO PRESENT ANOTHER SECTOR TO PRINTHEAD ARRAY
316

FIG. 3A

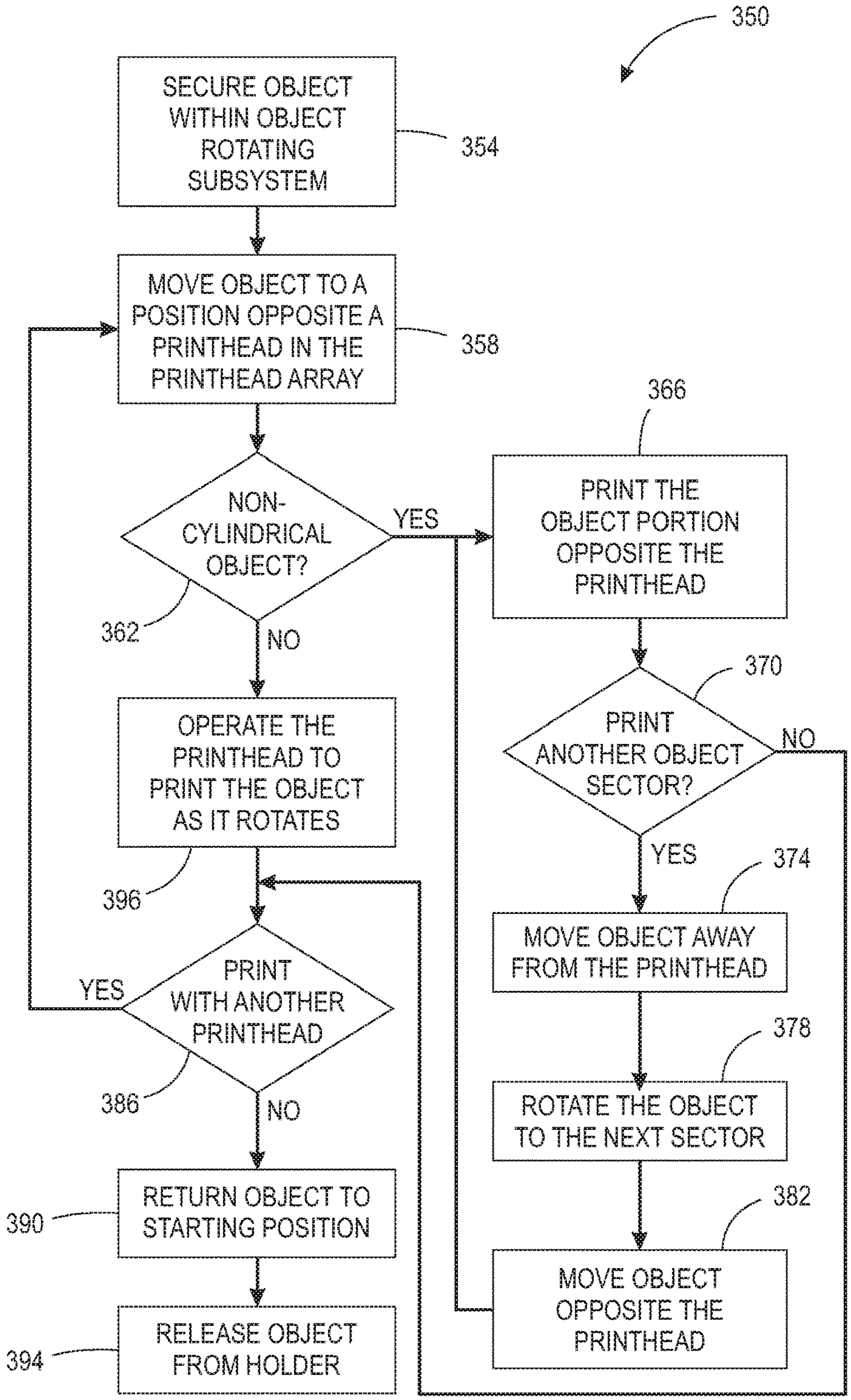
350
SECURE OBJECT WITHIN OBJECT ROTATING SUBSYSTEM
354
MOVE OBJECT TO A POSITION OPPOSITE A PRINTHEAD IN THE PRINTHEAD ARRAY
358
NON-CYLINDRICAL OBJECT?
362
YES
NO
366
PRINT THE OBJECT PORTION OPPOSITE THE PRINTHEAD
370
PRINT ANOTHER OBJECT SECTOR?
NO
YES
374
MOVE OBJECT AWAY FROM THE PRINTHEAD
378
ROTATE THE OBJECT TO THE NEXT SECTOR
382
MOVE OBJECT OPPOSITE THE PRINTHEAD
OPERATE THE PRINTHEAD TO PRINT THE OBJECT AS IT ROTATES
396
PRINT WITH ANOTHER PRINTHEAD
YES
386
NO
RETURN OBJECT TO STARTING POSITION
390
RELEASE OBJECT FROM HOLDER
394

FIG. 3B

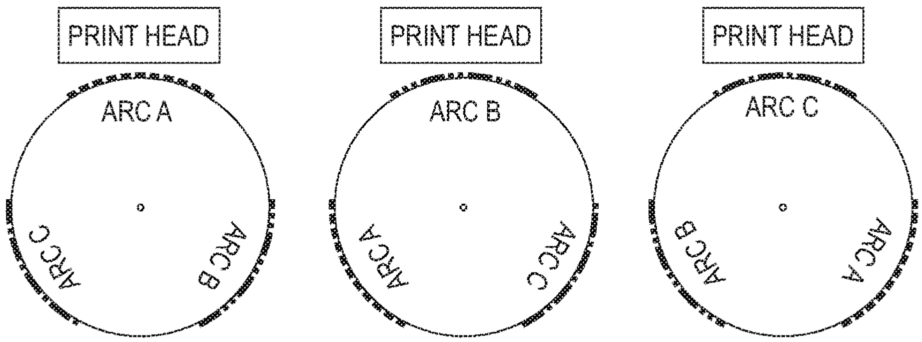
PRINT HEAD
ARC A
ARC C
ARC B
PRINT HEAD
ARC B
ARC A
ARC C
PRINT HEAD
ARC C
ARC B
ARC A

FIG. 4

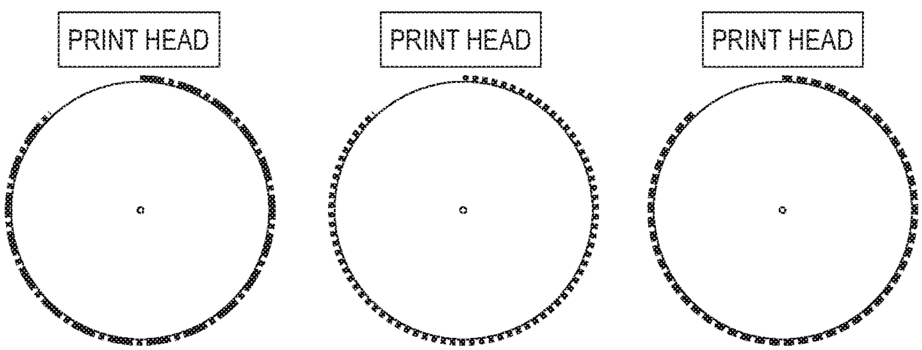
PRINT HEAD
PRINT HEAD
PRINT HEAD

FIG. 5

SYSTEM AND METHOD FOR ROTATING A THREE-DIMENSIONAL (3D) OBJECT DURING PRINTING OF THE OBJECT

TECHNICAL FIELD

This disclosure relates generally to a system for printing on three-dimensional (3D) objects, and more particularly, to systems that print on cylindrical or other rounded objects.

BACKGROUND

Commercial article printing typically occurs during the production of the article. For example, ball skins are printed with patterns or logos prior to the ball being completed and inflated. Consequently, a non-production establishment, such as a distribution site or retail store, for example, in a region in which potential product customers support multiple professional or collegiate teams, needs to keep an inventory of products bearing the logos of various teams popular in the area. Ordering the correct number of products for each different logo to maintain the inventory can be problematic.

One way to address these issues in non-production outlets is to keep unprinted versions of the products, and print the patterns or logos on them at the distribution site or retail store. Printers known as direct-to-object (DTO) printers have been developed for printing individual objects. These DTO printers have a plurality of printheads that are typically arranged in a vertical configuration with one printhead over another printhead. These printheads are fixed in orientation. When the objects to be printed are rounded, such as balls, water bottles, and the like, a complete image cannot be printed on the surface because the rounded surface falls away from the planar face of the printheads. Enabling DTO printers to be able to print images on all or a portion of the circumference of a rounded object would be beneficial.

SUMMARY

A new three-dimensional (3D) object printing system enables most or all of the circumference of rounded objects to be printed. The printing system includes at least one printhead, the at least one printhead being configured to eject marking material, an object rotating subsystem configured to hold an object and to move the object past the at least one printhead to receive marking material ejected from the at least one printhead. The object rotating subsystem has a first actuator, a chuck operatively connected to the first actuator, the chuck being configured to grip a portion of the object, and a controller operatively connected to the first actuator. The controller is configured to operate the first actuator to rotate the chuck and the object gripped by the chuck to enable the at least one printhead to print a portion of a circumference of the object that is longer than a width of the at least one printhead.

An object rotating subsystem enables most or all of the circumference of rounded objects to be printed in DTO printers. The object rotating subsystem includes a first actuator, a chuck connected to the first actuator, the chuck being configured to grip a portion of the object, and a controller operatively connected to the first actuator. The controller is configured to operate the first actuator to rotate the chuck and the object gripped by the chuck to enable at least one of the printheads to print a portion of a circumference of the object that is longer than a width of the at least one printhead.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing aspects and other features of a printing system and an object rotating subsystem that enables most or all of the circumference of rounded objects to be printed are explained in the following description, taken in connection with the accompanying drawings.

FIG. **1**A is a schematic diagram of a side view of a DTO printing system having an object rotating subsystem that enables most or all of the circumference of rounded objects to be printed.

FIG. **1**B is a schematic diagram of a view of the object rotating subsystem of FIG. **1**A from a printhead ejecting material onto the object held by the subsystem.

FIG. **2** depicts an embodiment of the object rotating subsystem used in the printing system of FIG. **1**.

FIG. **3**A depicts a process for operating the printer of FIG. **1** that rotates an object held by the object rotating subsystem.

FIG. **3**B depicts an alternative process for operating the printer of FIG. **1** that rotates an object held by the object rotating subsystem.

FIG. **4** depicts printing of discontinuous sectors of the circumference of the object held by the object rotating subsystem shown in FIG. **1**A.

FIG. **5** depicts continuous printing of the circumference of the object held by the object rotating subsystem shown in FIG. **1**A.

DETAILED DESCRIPTION

For a general understanding of the present embodiments, reference is made to the drawings. In the drawings, like reference numerals have been used throughout to designate like elements.

FIG. **1**A depicts a side view of a direct-to-object (DTO) printing system **100** configured to print the surface of an object **104** secured within an object rotating subsystem **108** as the subsystem **108** moves the object **104** past an array **112** of printheads **118**. As used in this document, the word "printhead" means a component having a plurality of ejectors configured to eject marking material. The marking material ejected by an ejector is dependent upon the marking material source to which the ejector is fluidically connected. The object rotating subsystem **108** slides bidirectionally along member **116** as indicated by the arrow in the figure. The controller **124** is configured to operate the actuator **128** to move the object rotating system **108** after the object **104** is mounted into the subsystem **108**. Controller **124** is also operatively connected to an actuator **138** that is configured to move either the subsystem **108**, the printhead array **112**, or both for movement towards and away from one another. A distance sensor **142** is associated with the printhead array **112**. The sensor **142** is configured to generate signals corresponding to a distance between the printhead array **112** and the object **104** when the object **104** is opposite the printhead array. The controller **124** receives these signals and operates the actuator **138** to move the printhead array **112** or the subsystem **108** or both relative to one another. Controller **124** is also configured to operate the printheads **118** in the array **112** to eject marking material onto the surface of the object **104**. If one or more of the printheads **118** in the array **112** ejects ultraviolet (UV) marking material, then the UV curing device **120** is operated by controller **124** to cure the UV material. As used in this document, "UV light" refers to light having a wavelength that is shorter than visible light, but longer than X-rays. The wavelength of such light is about 10 nm to about 400 nm.

One embodiment of the subsystem **108** is shown from the perspective of being opposite a printhead in FIG. **1**B. Subsystem **108** includes a pair of sleeves **132** that receive the member **116**. At least one of the sleeves **132** is operatively connected to the actuator **128** so the controller **124** can operate the actuator **128** to move the subsystem **108** along the member **116** bidirectionally. This bidirectional movement is called movement in a process direction. The configuration shown in the figure offsets the actuators **140** and **242** from the member **116**. The printheads **118** are offset in the cross-process direction from the longitudinal axis of the member **116** to enable the printheads to eject marking material towards the object **104** held by the subsystem **108**. Likewise, the UV curing device **120** is offset in the cross-process direction to enable the UV curing device to direct UV light toward the image on the object **104** to cure UV curable material on the object. Actuator **140** is mechanically connected to one of the sleeves **132** and is operatively connected to the controller **124**. A holder **212** is mounted to the output shaft **144** of the actuator **140**. The holder **212** is configured to grip and hold a portion **136** of the object **104** as the actuator **140** is operated by the controller **124** to rotate the object **104** as explained in more detail below. An extension **230** rotatably mounted to the output shaft **234** of the actuator **242** supports the bottom of the object **104**. The actuator **242** is connected to a sleeve **132** and the actuator **242** displaces its output shaft **234** toward and away from the object **104** to enable an object **104** to be installed and removed from the object rotating subsystem **108** as explained more fully below.

FIG. **2** is an illustration of an embodiment of the object rotating subsystem **108** that can be used in the printing system **100**. As used in this document, the word "subsystem" refers to two or more components that are operated to perform a particular function within a larger system. Although not depicted in FIG. **2**, the controller **124** operates the actuator **128** to move the sleeves **132** and the subsystem **108** past the printhead array **112** and the UV curing device **120** in the process direction as noted above with reference to FIG. **1**B. As shown in FIG. **1**B and FIG. **2**, the actuator **140** of subsystem **108** can be an electrical motor having an output shaft **144** on which a holder **212** is mounted. FIG. **2** further depicts the actuator **140** being electrically connected to an electrical power source **216** through an electrical switch **220**. The controller **124** is operatively connected to the electrical switch **220** to enable the controller to operate the switch **220** and selectively connect the actuator **140** to electrical power. Once at least a portion **136** of an object **104** is secured within the holder **212**, the controller **124** can operate the actuator **140** through the switch **220** to rotate the object. As the object rotating subsystem **108** moves past the printheads **118** in the array **112** (FIG. **1**A), rotation of the object enables a portion or the entire circumference of the object to be printed by one or more of the printheads. In one embodiment shown in FIG. **2**, a rotary encoder **224** is positioned next to the output shaft of the actuator **140** to enable the controller **124** to receive an electrical signal generated by the encoder that indicates the position of the shaft **144**. The controller **124** is configured with software that enables the controller to process the electrical signals from the encoder **224** and identify the portion of a circumference of the object **104** that faces a printhead **118** so a portion of an image can be printed on the object. In an alternative embodiment, the actuator **140** is a stepper motor and the controller **124** identifies the position of the object grasped by the holder **212** with reference to the pulses sent to the actuator to rotate the holder and the object. In this embodiment, an encoder is not required to enable the controller to identify the portion of the object surface facing the printheads.

The holder **212** can be a known collet chuck, a three-jaw chuck, a collar configured to grip structure located at an extremity of an object to be printed, a granular material holder, or the like. As used in this document, the word "holder" means any device configured to secure an object to be printed. As used in this document, the words "collar" and "chuck" mean a planar member having an opening and at least one movable member that varies the size of the opening to secure selectively an object with a predetermined orientation. A chuck can rotate in a first direction to advance the at least one movable member of the chuck into the opening within the chuck to secure an object in a known manner. Reversing the rotation of the chuck releases the object from the collar. In another embodiment of a chuck, the movable members of the chuck come together at the center of the opening within the chuck and rotation of the chuck in the first direction moves the members toward the circumference of the opening so the members can be inserted into an opening of an object, such as the mouth of a bottle, and the rotation in the first direction urges the members against the circumference of the object opening to hold the object for printing. Reversing the rotation of the chuck brings the members together in the center of the opening to reduce the pressure against the circumference of the object opening so the object can be removed. As used in this document, the term "granular material holder" means a pliable container filled with granular material that has its interior fluidically connected to an air evacuation and air pressurization source to enable air between grains for the granular material to be removed to secure a portion of an object deforming the container and to urge air between grains to release the object portion.

As shown in FIG. **2**, the output shaft **234** of the actuator **242** in the object rotating subsystem **108** includes an extension **230** that engages the bottom of the object **104**. The extension **230** is rotatably mounted to the output shaft **234** by a bearing or the like. As the actuator **140** rotates the object **104**, the extension **230** rotates about the output shaft **234** to enable the object to rotate. The output shaft **234** is operatively connected to actuator **242**, which is configured to move the output shaft **234** bidirectionally in the vertical direction. The controller **124**, which is operatively connected to the actuator **242**, operates the actuator **242** to move the extension **230** to a position where extension **230** engages a bottom surface of the object **104** held at its other end by the holder **212**. In this position, the extension **230** helps support the object **104** during printing and while it rotates freely as the actuator **140** turns the output shaft **144** and the object **104**. The operation of the actuator **242** varies the distance between the extension **230** and the holder **212** to accommodate objects of different lengths. Once printing of the object is completed and the subsystem **108** returns to its starting position, the holder **212** is operated to release one end of the object **104** and the actuator **242** is operated to lower the extension **230** so the object **104** can be retrieved from the subsystem **108**.

A process for operating the printer **100** is shown in FIG. **3**. In the description of the process, statements that the process is performing some task or function refers to a controller or general purpose processor executing programmed instructions stored in non-transitory computer readable storage media operatively connected to the controller or processor to manipulate data or to operate one or more components in the printer to perform the task or function. The controller **124** noted above can be such a controller or processor. Alternatively, the controller can be implemented with more than one processor and associated circuitry and components, each of which is configured to form one or more tasks or functions described herein. Additionally, the steps of the method may be performed in any feasible chronological order, regardless of the order shown in the figures or the order in which the processing is described.

FIG. **3**A is a flow diagram of a process that implements the rotating of the object being printed described above with either embodiment of the rotating object subsystem **108**. The process **300** begins with the holder **212** being operated to secure the object **104** in the subsystem **108** and the actuator **242** being operated to support the bottom of the object with the extension **230** (block **304**). The controller **124** operates the actuator **128** to move the object **104** by the printheads **118** in the array **112** as the controller operates the printeheads to print the sector of the object facing the printheads (block **308**). If another sector of the object is to be printed (block **312**), then the controller **124** operates the actuator **140** to rotate the object **104** after the object has past the last printhead **118** in the array **112** to the next sector to be printed (block **316**). The controller **124** operates the actuator **128** to move the object by the printheads **118** in the opposite direction so the printheads can print the sector facing the printheads (block **312**). This process of rotating the object and then passing the object past the printheads continues until all of the sectors on the object circumference that need printing are printed. At that time, the controller **124** operates the actuator **128** to return the object to its starting position (block **320**), where it can be released from the holder **212** (block **324**).

A flow diagram of an alternative process that implements the printing of an object held by either embodiment of the rotating object subsystem **108** is shown in FIG. **3**B. The process **350** begins with the holder **212** being operated to secure the object **104** in the subsystem **108** and the actuator **242** being operated to support the bottom of the object with the extension **230** (block **354**). The controller **124** operates actuator **128** to stop the object opposite one of the printheads **118** in the array **112** (block **358**). An operator can enter data identifying the object configuration prior to the printing of the object. When the object is non-cylindrical (block **362**), the object sector opposite the printhead is printed (block **366**) and the process determines whether another object sector is to be printed (block **370**). The printing performed by the processing in block **366** can include moving the object vertically by a small increment to print the sector if the vertical height of the image is greater than the height of the ejector array in the printhead currently being used to print the sector. If another sector is to be printed, the controller **124** operates the actuator **138** to move the array **112**, the subsystem **108**, or both relative to one another with reference to the signals from sensor **142** prior to rotating the object (block **374**). Once the object and array have been separated by an appropriate distance to enable rotation of the object without striking the array, the object is rotated (block **378**) and the object returned to a distance appropriate for printing another sector of the non-cylindrical object by controller **124** operating actuator **138** (block **382**). This sector is printed (block **366**) and the process continues until all of the sectors for the object circumference opposite the printhead are printed (block **370**). When all of the sectors of the current perimeter are printed, the process determines whether the perimeter is to be printed with another printhead (block **386**). If it is, then the processing of blocks **358** to **382** is repeated to print the perimeter with another printhead. Once the perimeter has been printed by all of the printheads, the object is returned to its starting position (block **390**) and released from the holder (block **394**). If the object is cylindrical, then it can be rotated without striking the printheads. In this situation, the first printhead at which the object stopped is operated to print the circumference as the object is rotated (block **396**). The printing performed by the processing in block **396** can include moving the object vertically by a small increment to print the sector if the vertical height of the image is greater than the height of the ejector array in the printhead currently being used to print the sector. If the circumference is to be printed with another printhead (block **386**), the object is moved opposite the printhead (block **358**) and rotated while being printed with the printhead (block **396**). This process continues until all of the printheads have printed the circumference. At that time, the object is returned to its starting position (block **390**) and released from the holder (block **394**).

The rotation of the object **104** in the processes of FIG. **3**A and FIG. **3**B can present another portion of the circumference or perimeter for printing that is separated from the first printed portion by a predetermined distance, as depicted in FIG. **4**. Thus, different sectors of a circumference or perimeter of the object can be printed, to avoid a protrusion or depression in the surface such as a handle, Cylindrical objects can be rotated by the process in FIG. **3**B at block **396** to enable printing of a continuous image around all or most of the circumference of the object **104**, as depicted in FIG. **5**. In the process of FIG. **3**A, the rotation of the object that occurs after the object has passed the printhead array can either present non-contiguous sectors for printing or continuous sectors for printing regardless of the configuration of the object.

It will be appreciated that variations of the above-disclosed apparatus and other features, and functions, or alternatives thereof, may be desirably combined into many other different systems or applications. For example, while the embodiments described above have been illustrated with a vertical configuration, the printing system and the object rotating subsystem can be configured for moving an object through a printer in other directions. Various presently unforeseen or unanticipated alternatives, modifications, variations, or improvements therein may be subsequently made by those skilled in the art, which are also intended to be encompassed by the following claims.

What is claimed is:

1. A printing system comprising:

at least one printhead, the at least one printhead being configured to eject drops of marking material;

a member having a first end and a second end, the first end of the member being at a greater gravitational potential than the second end and the at least one printhead being positioned opposite the member and between the first and second ends of the member;

an object rotating subsystem configured to hold an object and to move along the member between the first end and the second end to carry the object past the at least one printhead to enable the at least one printhead to eject drops of marking material onto the object, the object rotating subsystem having:

a first actuator;

a holder operatively connected to the first actuator, the holder being configured to grip a portion of the object;

a second actuator having an output shaft;

an extension rotatably mounted to the output shaft of the second actuator, the extension being configured to support a planar surface of the object at an end of the object opposite the portion of the object gripped by the holder; and

a controller operatively connected to the first actuator and the second actuator, the controller being configured to operate the first actuator to rotate the holder and the object gripped by the holder to enable the at least one printhead to print a portion of a circumference of the object that is longer than a width of the at least one printhead and to operate the second actuator to extend the output shaft of the second actuator to move the extension into engagement with the planar surface of the end of the object opposite the portion of the object gripped by the holder and to retract the output shaft of the second actuator to support the object and move the object away from the holder after the holder releases the object.

2. The printing system of claim **1** wherein the holder is a chuck.

3. The printing system of claim **1** wherein the first actuator connected to the holder is a stepper motor.

4. The printing system of claim **3**, the object rotating subsystem further comprising:

a rotary encoder configured to generate an electrical signal indicative of an angular displacement of an output shaft of the first actuator; and

the controller is further configured to process the electrical signals generated by the rotary encoder to identify a position of a surface of the object.

5. The printing system of claim **4**, the object rotating subsystem further comprising:

an electrical power source;

an electrical switch operatively connected to the electrical power source and the first actuator; and

the controller is operatively connected to the electrical switch, the controller being further configured to operate the electrical switch to connect the electrical power source to the first actuator selectively.

6. The printing system of claim **5** further comprising:

a third actuator operatively connected to the object rotating subsystem; and

the controller is operatively connected to the third actuator, the controller is further configured to operate the third actuator connected to the object rotating subsystem to move the object rotating subsystem in a bidirectional process direction along the member.

7. The printing system of claim **6** further comprising:

a fourth actuator operatively connected to the at least one printhead, the fourth actuator being configured to move the at least one printhead toward and away from the object gripped by the holder of the object rotating system; and

the controller is operatively connected to the fourth actuator, the controller is further configured to operate the fourth actuator to move the at least one printhead toward and away from the object gripped by the holder of the object rotating subsystem.

8. The printing system of claim **7** further comprising:

a sensor configured to generate signals corresponding to a distance between the at least one printhead and the object gripped by the holder of the object rotating subsystem when the object rotating subsystem is positioned opposite the at least one printhead; and

the controller is operatively connected to the sensor, the controller is further configured to operate the fourth actuator to move the at least one printhead toward and away from the object gripped by the holder of the object rotating subsystem with reference to the signals received from the sensor.

9. The printing system of claim **1**, the controller being further configured to rotate the holder and the object gripped by the holder to enable the at least one printhead to eject marking material onto at least two portions of the circumference of the object that are separated by a predetermined distance, the two portions and the predetermined distance together being greater than a width of the at least one printhead.

10. The printing system of claim **1**, the controller being further configured to rotate the holder and the object gripped by the holder to enable the at least one printhead to eject marking material onto a continuous portion of the circumference of the object that is at least greater in distance than a width of the at least one printhead and up to a distance as long as a complete revolution of the object.

11. An object rotating subsystem configured to hold an object and to move the object past a plurality of printheads to receive marking material ejected from the printheads, the object rotating subsystem comprising:

a first actuator;

a member having a first end and a second end, the first end of the member being at a greater gravitational potential than the second end;

a holder connected to the first actuator, the holder being configured to grip a portion of the object and to move between the first and the second ends of the member;

a second actuator having an output shaft;

an extension rotatably mounted to the output shaft of the second actuator, the extension being configured to support a planar surface of the object at an end of the object opposite the portion of the object gripped by the holder; and

a controller operatively connected to the first actuator and the second actuator, the controller being configured to operate the first actuator to rotate the holder and the object gripped by the holder to enable at least one of the printheads to print a portion of a circumference of the object that is longer than a width of the at least one printhead and to operate the second actuator to extend the output shaft of the second actuator to move the extension into engagement with the planar surface of the end of the object opposite the portion of the object gripped by the holder and to retract the output shaft of the second actuator to support the object and move the object away from the holder after the holder releases the object.

12. The object rotating subsystem of claim **11** wherein the holder is a chuck.

13. The object rotating subsystem of claim **11** wherein the first actuator is a stepper motor.

14. The object rotating subsystem of claim **11** further comprising:

a rotary encoder configured to generate an electrical signal indicative of an angular displacement of an output shaft of the first actuator; and

the controller is further configured to process the electrical signals generated by the rotary encoder to identify a position of a surface of the object.

15. The object rotating subsystem of claim **14** further comprising:

an electrical power source;

an electrical switch operatively connected to the electrical power source and the first actuator; and

the controller is operatively connected to the electrical switch, the controller being further configured to operate the electrical switch to connect the electrical power source to the first actuator selectively.

16. The object rotating subsystem of claim **15** further comprising:

a third actuator operatively connected to the object rotating subsystem; and

the controller is operatively connected to the third actuator connected to the object rotating subsystem, the controller is further configured to operate the third actuator connected to the object rotating subsystem to move the object rotating subsystem in a bidirectional process direction.

17. The object rotating subsystem of claim **16** further comprising:

a fourth actuator operatively connected to the at least one printhead, the fourth actuator being configured to move the at least one printhead toward and away from the object gripped by the holder of the object rotating system; and

the controller is operatively connected to the fourth actuator, the controller is further configured to operate the fourth actuator to move the at least one printhead

toward and away from the object gripped by the holder of the object rotating subsystem.

18. The printing system of claim **17** further comprising:

a sensor configured to generate signals corresponding to a distance between the at least one printhead and the object gripped by the holder of the object rotating subsystem when the object rotating subsystem is positioned opposite the at least one printhead; and

the controller is operatively connected to the sensor, the controller is further configured to operate the fourth actuator to move the at least one printhead toward and away from the object gripped by the holder of the object rotating subsystem with reference to the signals received from the sensor.

19. The object rotating subsystem of claim **11**, the controller being further configured to rotate the holder and the object gripped by the holder to enable the at least one printhead to eject marking material onto at least two portions of the circumference of the object that are separated by a predetermined distance, the two portions and the predetermined distance together being greater than a width of the at least one printhead.

20. The object rotating subsystem of claim **11**, the controller being further configured to rotate the holder and the object gripped by the holder to enable the at least one printhead to eject marking material onto a continuous portion of the circumference of the object that is at least greater in distance than a width of the at least one printhead and up to a distance as long as a complete revolution of the object.

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